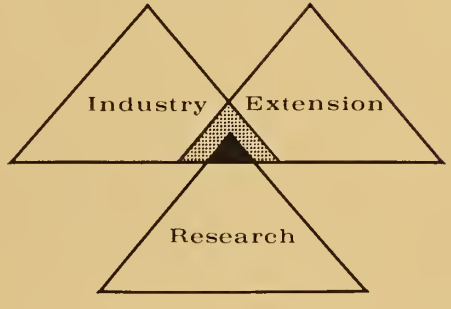
GUIDELINES FOR UNIFORM BEEF IMPROVEMENT PROGRAMS

Beef Improvement Federation Recommendation



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UNITED STATES DEPARTMENT OF AGRICULTURE — EXTENSION SERVICE

Beef producers now accept objective measurements as a management tool that provides important benefits to their own operations and to the future of their industry. This acceptance is demonstrated by the fact that more than 50 organizations in the United States now provide beef improvement programs, coordinated through the Beef Improvement Federation (BIF).

This publication outlines the pattern presently used for beef cattle improvement in the United States. It is the sincere desire of all the individuals and organizations involved in preparing this publication that it will extend the usefulness of beef cattle performance testing and perpetuate its use.

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C O N T E N T S

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Guidelines
for
Uniform Beef Improvement Programs

FOREWORD

In the early 1930's, research was started on the use of objective measurements for evaluating beef cattle. Within a few years it had been determined that there were a number of economically important traits that could be measured objectively. Most traits were shown to be sufficiently high in heritability to provide a sound basis for selection. Thus, the foundation for performance testing had been laid.

Performance testing has undergone thorough evaluation by researchers and producers, and has been proven to be important in economical beef production. The result has been a steady increase in the use of objective measurements as a basis for beef cattle improvement. It can now be said that the economic value of performance testing has broad acceptance within the beef industry.

An indication of the emphasis being placed on performance testing in the U.S. is that more than 50 organizations now provide beef cattle improvement programs. To extend and further improve performance testing, these organizations and other organizations with an interest in performance testing on February 1, 1968, formed the Beef Improvement Federation (BIF). The purposes of this organization are:

1. Uniformity. To work for establishment of accurate and uniform procedures for measuring and recording data concerning the performance of beef cattle, which may be used by participating organizations.

2. Development. To assist member organizations and/or their affiliates in developing their individual programs consistent with the needs of their members and the common goal of all recordkeeping programs.

3. Cooperation. To develop cooperation among all segments of the beef industry in compilation and utilization of performance records to improve efficiency in the production of beef.

4. Education. To encourage members to develop educational programs emphasizing the use and interpretation of performance data in improving the efficiency of beef production.

5. Confidence. To develop increased confidence of the beef industry in the economic potential of performance testing.

Member organizations include:

The Beef Cattle Improvement Associations or similar sponsoring organizations of beef cattle improvement programs of Alabama, California, Colorado, Florida, Georgia, Hawaii, Idaho, Illinois, Iowa, Kansas, Kentucky, Maryland, Massachusetts, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Mexico, New York, North Carolina, North Dakota, Ohio, Oregon, Pennsylvania, South Carolina, South Dakota, Texas, Utah, Virginia, Washington, West Virginia, Wisconsin, and Wyoming.

The national registry associations for the following breeds of cattle: Angus, Brahman, Charolais, Hereford, Limousin, Maine Anjou, Polled Hereford, Red Angus, Red Poll, Santa Gertrudis, Shorthorn, and Simmental.

Other national organizations: Performance Registry International, National Association of Animal Breeders, and American National Cattlemen's Association.

Associate member organizations are: American Breeders Service, Arizona Cattlemen's Association, International Brangus Breeders, Inc., Cache Valley Breeding Association, Curtiss Breeding Service, Inc., Midwest Breeders Service, Select Sires, Inc., and Carnation Farms Breeding Service.

Ex-officio member organizations are the Canadian Department of Agriculture, and the Extension Service and the Agricultural Research Service of the U.S. Department of Agriculture.

This publication was developed from reports of committees established by the Board of Directors of BIF. It represents an effort of this organization to extend the usefulness of beef cattle performance testing.

The guidelines in this publication are a revision of the Guidelines for Uniform Beef Improvement Programs recommended by the Beef Improvement Federation in April 1970 which revised the February 1965 report of the former U.S. Beef Cattle Records Committee. Like these previous reports, this publication is the result of a cooperative effort of Extension, research, and industry. The guidelines in this publication will be reviewed periodically and updated as indicated by research, experience, and "industry economics".

The Beef Improvement Federation and the U.S. Department of Agriculture intend to show no preference for or discrimination against any individual breed of cattle or organization.

INTRODUCTION

The objective of this publication is to outline procedures for measuring and recording beef cattle performance data. A second objective is to achieve greater uniformity of terminology and methods of measuring performance traits. This is important in accomplishing rapid and accurate communication and developing cooperation among all segments of the beef industry in compiling and utilizing performance records. It is not the intent of this publication to recommend a standard program applicable to all segments of the beef cattle industry. However, the economic potential of performance testing in beef production is highly correlated with communication and cooperation.

Economic traits of beef cattle include those that contribute to both productive efficiency and desirability of product. Rapid growth, efficient use of feed, regularity of reproduction, and carcasses with qualities preferred by packers and consumers are economic traits of major importance. Performance testing offers beef cattle breeders a way of measuring differences among animals in heritable characters. Performance levels for these characters are related to ability to transmit desired traits to offspring.

Differences among animals in traits of economic value are to a considerable extent, inherited differences. Thus, systematic measurement of these differences, the recording of the measurements and the use of records in selection will increase the rate of genetic improvement in individual herds and thus in a breed and ultimately the total cattle population.

Differences among animals are due to two major causes, genetic and environmental. The observed or measured performance of each animal in each trait is the result of its heredity and the total environment in which it is raised. Research has shown that when cattle are kept under nearly equal conditions and their performance records are adjusted for known environmental differences, such as age, age of dam and sex, genetically superior animals can be identified. In addition to the environmental effects for which adjustments can be made, there are many random or chance environmental variables which contribute to errors in estimating relative breeding values of animals based on their own performance. The importance of some of these, such as differences in fill at time of weighing, can be appreciably reduced by following appropriate and uniform procedures. The weighing conditions should be the same for all animals that are to be compared.

The rate of improvement in a herd, breed, and population is dependent on (1) the percentage of observed differences between animals that is due to heredity (heritability), (2) the difference between selected individuals and the average of the herd or group from which they come (selection differential), (3) the genetic association among the traits upon which selection is based (genetic correlations), and (4) the average age of parents when the offspring are born (generation interval).

Records of performance are useful primarily to provide a basis for comparing cattle handled alike within a herd. Large environmental differences due to location, management, health and nutrition are likely to exist between herds or between different management groups within herds. Genetic differences between herds do exist, but only through a carefully controlled evaluation can these differences be assessed. Guidelines for a National Sire Evaluation Program which takes herd differences into account will be presented in this report. However, to identify high ranking individuals within a breed it is necessary to first identify high ranking individuals within herds. Thus, widespread use of performance testing within herds is the first essential step to beef improvement.

The principal features of effective record of performance programs are as follows:

1. All animals of a given sex and age are given equal opportunity through uniform feeding and management.

2. Systematic written records are kept of important traits of economic value on all animals.

3. Records are adjusted for known sources of variation, such as age of dam, age of calf, and sex.

4. Records are used in selecting replacements (bulls and heifers) and in culling poor producers.

5. Nutritional program and management practices are practical and compatible with those where progeny of the herd are expected to perform and are uniform for the entire herd.

Fertility and the various components which contribute to it have been found to be of low heritability. However, fertility is

economically the most important trait in the beef industry, and in herds where fertility is low, sizable selection differential can be achieved. Extremely low fertility or sterility are self eliminating but cattle of this kind need to be identified and eliminated from the herd for purely economic reasons. Thus, maintaining complete records on all cows and fertility records on bulls in breeding herds is recommended.

Prospective herd sires or replacement heifers should not be saved from either sires or dams of subnormal fertility.

Throughout this publication, the terms "weight ratio", "gain ratio", or "conformation score ratio" are used to refer to the performance of an individual relative to the average of all animals in the same group. It is calculated as:

$$\frac{\text{Individual Record}}{\text{Average of animals in group}} \times 100$$

It is a useful device for quickly visualizing the relative rankings of individuals in a group. To some degree it adjusts for environmental differences between groups. This means that two animals with equal weight ratios in two different herds or groups can be compared more validly on the basis of ratios than on basis of actual weights. It should be emphasized, however, that the possibility of true genetic differences between herds or groups limits the usefulness of ratios for between-herd or between-group comparisons.

FARM AND RANCH PRE-WEANING AND POST-WEANING TESTING PROGRAMS

Both pre- and post-weaning growth are of primary economic importance to the beef industry because of their high association with maternal ability, efficiency of gain and pounds of retail trimmed beef produced. However, the heritability estimates for these measures of growth depend on how they are handled with respect to sex of animal, age of dam, and in relation to contemporary animals. Recommendations developed for this section are based on available research information tempered by practicability in use and application. Measurements taken according to these recommendations should maximize accuracy of selection for pre- and post-weaning records.

PRE-WEANING PHASE

Measurement of weaning weight (205 days). Weaning weights are measured to evaluate differences in mothering ability of cows and differences in growth potential of calves. For best estimates of genetic worth for weaning weight, it is necessary to adjust individual calf records to a standard basis. It is recommended that the weaning weight be standardized to 205 days of age and a mature dam equivalent. It is also recommended that weights be recorded as close to 205 days as possible but in no case at a greater age range than 160 to 250 days. Calves weaned outside this range would be reported as irregular + or - with the exception of early weaned heifers which can be accounted for by a special management code and handled as a separate management group in computing 205 day weights and ratios. Records of heifers in this management code should not be adjusted for age of dam since appropriate correction factors are not available. Research results indicate that early weaning may enhance subsequent mothering ability of heifer calves.

It is recommended that 205 day weights be computed on the basis of average daily gains from birth to weaning. This is accomplished by: (1) subtract a constant of 70 lbs. (or actual birth weight, if available) for birth weight from actual weight at weaning; (2) divide by age in days at weaning, to obtain average daily gain (3) multiply the average daily gain by 205; and (4) add the 70 lbs. that was subtracted initially for birth weight (or actual birth weight).

This provides an estimated 205 day weight, unadjusted for age of dam or sex of calf. This procedure is summarized by the following formula:

$$\text{Unadjusted 205 day weight (lbs.)} = \frac{\text{actual wt.} - 70}{\text{age in days}} \times 205 + 70$$

To establish a uniform procedure for computing age of dam, the following classification is recommended:

Age range	Age of dam
1 yr. - 9 mos. to 2 yrs. - 9 mos.	2 year olds
2 yrs. - 9 mos. to 3 yrs. - 9 mos.	3 year olds
3 yrs. - 9 mos. to 4 yrs. - 9 mos.	4 year olds
etc.	

To adjust for age of dam, the following adjustment factors are recommended:

Age of dam

- 2 year olds - multiply computed 205 day weight by 1.15
- 3 year olds - multiply computed 205 day weight by 1.10
- 4 year olds - multiply computed 205 day weight by 1.05
- 5 through 10 year olds - no adjustment
- 11 year olds and up - multiply computed 205 day weight by 1.05

Weaning weight ratio. Records on 205 day weight and 205 day weight ratio, adjusted for age of dam on individual animals should be reported and/or published on the basis of each sex (within sex basis without sex adjustment). Weaning weight ratios within sex groups are calculated by dividing each individual's 205 day weaning weight adjusted for age of dam by the average of its sex group and expressing it as a percent of its sex group average. Thus, weaning weight ratios provide a record of each individual's deviation from the average of their contemporaries in terms of percent. They are useful in ranking individuals of each sex for making selections.

Sire, dam, and group summaries adjusted for sex. In the case of sire, dam, and group summaries for 205 day adjusted weaning weight where it is necessary to adjust to a single sex, the adjustment should be to a bull or steer basis depending on the majority of male calves in the herd or group. It is recommended that in most purebred herds adjustment should be to

a bull basis. Allow a 10 percent difference between bulls and steers. Thus, adjust heifer weights to a bull basis by multiplying by 1.10 and steer weights to a bull basis by multiplying by 1.05. In commercial herds where the majority of male calves are steers, records of heifer calves should be adjusted upward to a steer basis by multiplying by 1.05 and records of any bull calves should be adjusted to a steer basis by subtracting 5 percent or multiplying by .95.

Both age of dam and sex adjustments required for complete accuracy are known to vary from herd to herd and also with feeding level in the same herd. However, large numbers of records are required for accurately determining adjustment factors. Thus, unless there is strong evidence of the need for different factors, it is recommended that the above adjustments be used in computing adjusted 205 day weaning weight before computing average weight ratios to be used in sire, dam, or group summaries. Weaning weight ratios for sire, dam, and group should be calculated by dividing each individual's 205 day weight adjusted for sex, and age of dam by the average of the calves in its management code group, and expressing it as a percent of its management code group average. Sire, dam, and group summaries are made by averaging the weight ratios of the animals involved.

Most Probable Producing Ability (MPPA). It is recommended that MPPA be included on Produce of Dam summaries and that ranking of dams be based on MPPA for 205 day weaning weight ratio. This is needed to compare dams which do not have the same number of calf records in their averages. For example, suppose six cows have the following records of production:

Cow	No. Calves	Avg. wn. wt. ratio	MPPA
A	1	85	94.0
B	2	88	93.2
C	4	90	92.7
D	3	110	106.7
E	4	112	108.8
F	1	115	106.0

MPPA is most helpful for identifying the lowest producing cows to be culled. In the example, cow A has the lowest lifetime average. However, this is for only a single calf for which environmental conditions or the calf's genetic potential for growth might have been below the average of what the cow would normally produce. One or more calves from cows B or C could also have had a record of 85 or less. All three cows are probably low producers but MPPA enables more accurate culling and in this example indicates that cows B and C are slightly lower producing cows than A.

MPPA for weaning weight ratio is computed by the following formula:

$$MPPA = \overline{H} + \frac{NR}{1 + (N-1)R} (\overline{C} - \overline{H})$$

where $\overline{H}$ = 100, the herd average weaning weight ratio,
N = the number of calves included in the cows average,
R = .4, the repeatability factor for weaning weight ratio,
and $\overline{C}$ = average for weaning weight ratio for all calves the cow has produced.

Weaning conformation score. The BIF recommends a conformation score based on a scale of 3 to 17 as detailed in the following table.

Conformation Score	Description of Breeding Cattle
17-16-15	Cattle eligible to receive these scores have no more than minor faults in any of the major items of conformation. Cattle in this category are basically correct in their skeletal and muscular structure, are outstanding in muscular development and have optimum outside fat considering the manner in which they have been developed. Beef character in abundance describes cattle in this series. The top end of this series describes beef cattle of basically ideal conformation. Bulls in this series are strictly herd bull prospects from a conformation standpoint and females eligible for these scores possess the conformation desired for outstanding herd replacements.

Conformation Score	Description of Breeding Cattle
14-13-12	Cattle eligible to receive these scores have no more than moderate faults in their muscular and skeletal structure. Their muscular development is usually less than outstanding but is average to superior. Skeletal structure is basically sound. Cattle in this category should include a relatively high percentage of the animals in the better purebred herds. The top end of this series represents the lowest end of herd bull prospects and the top end of commercial bulls from a conformation standpoint. The top end of this series describes superior female replacements for purebred herds, the middle of this series describes good female replacements, while the bottom end describes the females that are no more than satisfactory as replacements in purebred herds. The score of 14 describes superior commercial bulls; 13 describes good commercial bulls; and 12 describes satisfactory commercial bulls from a conformation standpoint. The top end of this series represents the practical top of commercial cattle. The lower end of this series includes a reasonably high percentage of the better commercial replacements.

Conformation Score	Description of Breeding Cattle
11-10-9	Cattle in this category may have moderate to severe faults in some items of skeletal and muscular structure. Muscular development is usually average to inferior. Females in this category should be sound enough in their skeletal structure to perform their function. A high percentage of the female replacements from average commercial herds would be in the middle and top scores of this series. The lowest score in this series describes poor female replacements for commercial herds.

Conformation Score	Description of Breeding Cattle
8-7-6	Cattle in this category are usually decidedly lacking in beef character, may have serious structural defects and may be definitely lacking in muscling. Represented here are the extreme bottom end of beef cattle.

Conformation Score	Description of Breeding Cattle
5-4-3	Extremely thinly fleshed cattle. Represented here are the thinnest fleshed of dairy cattle.

Conformation score should also be reported using a ratio computed separately for each sex-management code group. Both conformation score and conformation score ratios should be reported in sire, dam, and group summaries. MPPA can also be computed for conformation score ratios using the same formula as previously shown on page 10 but with R = .3. A composite index combining weaning weight ratio and conformation score ratio into one numerical measure is not recommended, since this would suggest that a single selection criteria would apply across all herds as far as growth and conformation are concerned.

POST-WEANING PHASE

Measurement of yearling weight (365 days) or long yearling weights (452 or 550 days). Yearling weight at 365 days or long yearling weights at 452 or 550 days are particularly important because of their high heritability and high genetic association with efficiency of gain and pounds of retail trimmed boneless beef produced.

Yearling weights should be computed and reported separately for each sex. In on-the-farm or ranch tests, the post-weaning period should start on the date weaning weights are obtained (i.e., actual weaning weight is used as initial weight on test). Research results show that the age of dam effects on 365 day weight are of approximately the same magnitude as age of dam effects at weaning. For this reason, it is desirable to add post-weaning gains in a 160 day post-weaning period to 205 day weaning weight adjusted for age of dam to arrive at adjusted 365 day weight. The following formula is recommended to compute:

$$\text{Adjusted 365 day wt.} = \frac{\text{actual final wt. - act. wn. wt.}}{\text{number of days between wts.}} \times 160$$

$$+ \text{ wn. wt. (205 days) adjusted for age of dam}$$

The period between weaning weight and final weight should be at least 160 days; final weight should not be taken at less than 330 days of age for any individual; and the average age for each sex management group should be at least 365 days. It is recommended that the number of days between weaning and final weight be the same for all animals of the same sex in a herd. By use of this procedure, it is necessary to obtain only weaning weight and yearling weight on each animal. Also, all periods in an animal's life are accounted for, i.e., no "loafing" periods.

The procedure of using adjusted 365 day weights as a measure of yearling weight will apply primarily to herds that develop bulls on a rather high level of concentrate feeding starting at weaning time. For herds that prefer to develop bulls more slowly, and with the lower level of feeding more practical and applicable for growing out potential replacement heifers, a long yearling weight may be used as an alternative to adjusted 365 day weights. This is accomplished by measuring growth rate in periods of approximately 247 or 345 days post-weaning with weaning weight and date being the initial weight and date of the post-weaning period.

Adjusted long yearling weight (452 or 550 days) for each sex should be computed in the same manner as adjusted 365 day weight.

$$\text{Adjusted 550 day wt.} = \frac{\text{actual final wt. - actual wn. wt.}}{\text{number of days between weights}} \times 345$$

$$+ \text{ wn. wt. (205 days) adj. for age of dam}$$

and 247 would be substituted for 345 in the equation to compute 452 day weight. For bulls grown on intermediate feed levels, adjusted 452 day weight gives a better evaluation of growth potential than 365 day weight. Taking them to 550 days on a standard ration might put them in higher condition than desired. Final weight should not be taken at less than 500 days of age when estimating 550 day weight, or at less than 400 days when estimating 452 day weight.

Weight ratios. Weight ratios for either adjusted 365 day weight (yearling), adjusted 452 day weight or adjusted 550 day weight (long yearling) should be computed separately for each

sex-management code group. Weight ratios should be reported for individual animals listed separately for each sex-management code group for ease of ranking individuals of each sex in making selections.

Weight ratios for yearling weights can be biased downward if lighter calves are culled at weaning. Research has indicated that with 25 percent, 50 percent, and 73 percent culling for low weaning weight, yearling weight ratios would be underestimated by 3 percent, 6 percent, and 8 percent for each calf, respectively, if the average yearling weights of selected calves are used to compute the ratio because the average yearling weights of selected calves would exceed those for all calves weaned.

To adjust yearling weight ratio for selection on weaning weight (or culling of lighter calves at weaning) the following formula is recommended for computing yearling weight ratio:

$$\frac{W + P}{\overline{W}_u + \overline{P}_s} \times 100$$

where W = adjusted 205 day weight of the individual,
P = the 160 day postweaning gain of the individual = 160 x postweaning average daily gain (247 or 345 should be substituted for 160 in computing adjusted 452 or 550 day weight ratios),
$\overline{W}_u$ = the average 205 day adjusted weight of all calves weaned contemporarily with the calf in question,
and $\overline{P}_s$ = the average 160 day postweaning gain of all calves tested in a contemporary sex-management group.

If no calves are culled at weaning, this is the same as dividing the individuals adjusted 365 day weight (or adjusted 452 or 550 day weight) by the average of all animals in the sex-management code group and multiplying by 100 to express the ratio as a percent of its sex-management code group. By keeping the averages corresponding to each calf on file, this type of indexing can be done even for non-contemporary weaning groups assembled for central tests.

Sire and group summaries for yearling weight ratio should be computed as:

$$\frac{\overline{W}_{ug} + \overline{P}_{sg}}{\overline{W}_u + \overline{P}_s} \times 100$$

where $\overline{W}_{ug}$ = the sire progeny group average 205 day adjusted weight for all calves weaned,

$\overline{P}_{sg}$ = the average 160 postweaning gain (247 or 345 for 452 or 550 day weights, respectively),

$\overline{W}_{u}$ = the average 205 day adjusted weight of all calves weaned contemporarily with the calf in question,

and $\overline{P}_{s}$ = the average 160 day postweaning gain of all calves tested in a contemporary sex--management group.

Final conformation score. Final conformation scores taken at the end of the post-weaning test can also be recorded using a 17 point system as previously described. These should also be reported in the form of a ratio calculated on a within sex-management code basis and should be included in sire, dam, and group summaries.

CENTRAL TESTING STATIONS

Central testing stations are locations where animals are assembled from several herds to evaluate differences in some performance traits under uniform conditions. Uses of central testing stations include: (1) comparing individual performance of potential seed-stock herd sires to similar animals from other herds; (2) comparing bulls being readied for sale to commercial producers; (3) finishing steers or heifers scheduled for slaughter as part of progeny test programs for growth and carcass traits; (4) as an educational tool to acquaint breeders with record of performance; and (5) estimating genetic differences between herds or between sire progenies in gaining ability, feed conversion, conformation, and carcass characteristics.

It is important that the objectives of a central testing station be clearly defined and procedures designed to accomplish the objectives. Since specific objectives and procedures may vary with location, only general principles will be discussed here.

Bull buyers have to decide on (1) which herds to buy bulls from and (2) which bull or bulls to buy within a herd. If the bulls are raised and fed entirely on the farm or ranch where dropped, the buyer has the nearly impossible task of deciding how much of the apparent superiority or inferiority of bulls in a specific herd is due to feeding and herdsmanship. Having them handled for part of their lives under standard conditions minimizes these effects and makes the task of the buyer easier, whether he is buying commercial bulls or herd sires for a purebred herd.

Similarly, if progeny test groups of steers from different herds are being fed out to determine the transmitting ability of the sires for growth rate, efficiency and carcass traits, sire comparisons are more accurate if all progeny are fed under standard conditions for the final feeding period.

Central tests are of limited usefulness for estimating genetic differences between herds. If this is the purpose of the test, at least five to ten head per herd should be tested annually for a minimum of three years. The larger the herd size, the greater the number will need to be to adequately sample the herd. The precision of the tests may be improved if five to eight progeny of each of two or more sires from each herd are tested each year permitting the assessment of within-herd differences to compare with between-herd differences. Further, efforts should be made to get a representative sample of animals from each herd on test

or little real information on herd differences will be accumulated. If central testing stations are used to estimate genetic differences between herds, it is also recommended that samples of bulls completing the evaluation be used in top-cross comparisons in commercial herds so that additional traits can be measured and the precision can be increased.

If the purpose is to evaluate genetic differences between herd sires through progeny testing, the sample of offspring must be representative or at least selected in the same manner. A minimum of six to eight progeny from each sire should be measured. These may be bull calves fed individually, in which case only growth, conformation and feed conversion could be evaluated, or they may be steers or heifers fed out and slaughtered to obtain carcass data.

If the purpose is solely to develop bulls and make objective performance information available to prospective buyers, the number of bulls per herd or per sire is immaterial. To be most useful, however, large numbers should be fed at a single location so buyers will have an adequate number from which to choose. Tests of this kind would be most useful as a service to small breeders, and if commercial-type feedlots were used, large numbers could be fed. Preferably, bulls should be entered in this type of test only if they meet rigid qualifications for pre-weaning rate of gain, soundness, and conformation score.

The recommendations for central test stations are the result of many years of research and experience designed to maximize reliability and clarity of reporting results.

However, even if all test stations followed these recommendations, comparison of gains made at different locations would still be invalid because many important differences cannot be eliminated. The most a central test can offer is reliable data for comparisons within test and within year.

The following procedures and policies are recommended for central testing of bulls:

(1) Age of calves at time of delivery to test stations should be at least 180 days and not more than 305 days.

(2) Herds from which bulls are consigned should be on herd testing programs for pre-weaning and post-weaning performance. Calves should have

completed the weaning phase of the performance records program and the following information should be submitted to the test station:

> Sire, dam, birth date, actual weaning weight and date, adjusted 205 day weight, within herd weaning weight ratio (based on average of all bull calves in same weaning season and management group), and the number of calves making up this average.

(3) There should be an adjustment or warm-up period of 21 days or more immediately prior to the test period.

(4) The length of test should be 140 days or more.

(5) Initial and final test weights should be an average of two full weights taken on different days.

(6) All bulls sold in a test sale should be examined by a competent veterinarian for reproductive and structural soundness.

(7) Test rations will vary according to locally available feeds and test objectives. Feeding should be ad lib. Rations between 60 and 70 percent total digestible nutrients (TDN) should be adequate for the expression of genetic differences in growth. The lower end of this range should result in few health problems and less excessive fattening.

(8) Sire group testing of bulls is more desirable than individual testing because it provides more information to the breeder and to the prospective buyers.

TEST STATION REPORTS

The 140 day average daily gain and gain ratio are the most important figures in test station results, because they measure growth during the period when the bulls are together under test conditions. Selection for 140 day gains should improve weaning weights and feedlot performance because some of the genes which

affect feedlot growth rate also affect pre-weaning growth rate. The gain ratio is obtained by dividing the individual's gain by the test group average and multiplying by 100. A ratio of 100 means the bull is exactly average in his group, 115 means he is 15 percent above the average, 90 means he is 10 percent below the average, etc. This ratio makes animal comparisons easier and is much more meaningful than the actual measurement.

Weaning weights and within-herd weaning weight ratios provide good comparisons of bulls which come from the same herd but are less useful for comparing bulls from different herds. This is the best available measure of the dam's milk production, so it is desirable to have a weaning weight above the average of the herd in which the calf was produced (i.e., within-herd weaning weight ratio above 100). Actual weaning weights and the date weighed are reported to provide information on gain during the interim period between weaning and initial test weights. Loss of weight or very low gains during this period may result in higher than normal gains during the subsequent test period. The size of this "compensatory" error in test gains would depend on the length of the interim period and the rate of gain.

The 365 day adjusted weight and 365 day weight ratio combine adjusted weaning weight and post-weaning gain into one composite measurement. The 365 day weight ratio is the best measure for comparing growth of calves from the same herd. It is very highly heritable (around 60 percent). However, among bulls in a central test, care must be exercised in using this measurement, because the weaning weight portion was not made under comparable conditions.

If the gain ratio and the 365 day weight ratio are very nearly alike, you probably have a very reliable estimate of gainability to one year of age. Weight-per-day-of-age is an alternate measurement of growth during this same period, but it does not include an adjustment for age of dam and can be biased by differences in age at weaning and post-weaning period length.

Efficiency of feed conversion is expressed as pounds of feed per 100 pounds of gain. It is difficult to measure. Most tests do not attempt to get individual feed conversion because it would require individual feeding. Where sire progeny groups are fed in separate pens, a good measure of the sire's ability may be obtained. This also provides some information on the individual half-brothers in the pen. Since size differences affect feed requirements, feed conversion must be adjusted to a common body weight to be meaningful. Fortunately, growth rate and gain

per unit of feed are highly correlated. It is estimated that selection for gain alone will result in 80 percent as much improvement in gain per unit of feed as selection directly for low feed requirement.

Conformation score or grade is optional among test stations. This measurement should be based strictly on skeletal soundness and indications of carcass desirability (including carcass weight and cutability). Since it is an "opinion value", it is less useful to the bull buyer than the other measurements. Each buyer should make his own visual evaluation after evaluating the records of production.

Rations vary considerably among test stations particularly in level of energy. This variation causes some differences in the average daily gains of different tests. These differences caused by feed are not heritable. Bulls can usually be compared as accurately if the test average is near 2.5 pounds per day as they can if the test average is higher than 3.0 pounds per day. Breed differences and local preferences must be considered in deciding exactly what the average gain should be. High roughage rations which produce moderate gains are likely to result in less excessive fattening and fewer health problems than higher energy rations. Bull calves grown on higher roughage rations should adapt fairly easily to a variety of feed and pasture conditions after the test and they should be ready for service within less time than fatter bulls.

GENERAL CONSIDERATIONS

Even under the best possible conditions at a central test station, not all pre-test environmental effects can be eliminated. Therefore, small differences in measurements are not very meaningful. Some bulls may be sick or off feed at just the wrong time, but do not be misled by excuses. Even if a bull was sick, there is no way to adjust the data. The only safe thing to do is to assume that all had equal opportunity.

The buyer must decide which traits will receive most emphasis in his selection program. Only a few traits and a limited number of bulls can be measured at test stations. Testing does not improve the bulls, it only helps to identify the superior ones. Complete herd performance programs in the seedstock herds of the nation are necessary to achieve satisfactory genetic progress in the beef cattle industry.

The following form and definition of measurements is recommended for general use by test stations. Several optional measurements are also listed.

MEASUREMENTS RECOMMENDED FOR ALL TEST STATIONS

OPTIONAL MEASUREMENTS FOR ALL TEST STATIONS

		WEANING				GAIN TEST					YEARLING		YEARLING						
Lot No.	Birth Date	Actual Wt.	Weaning Date	Adj. 205 day Wt.	W.W. Ratio W/in Herd and No.	(Date) Initial Test Wt.	(Date) Final Test Wt.	Age in Days	ADG	Test Gain Ratio	Adj. 365 Day Wt.	365 Day Wt. Ratio	Wt. Per Day of Age	Conf. Score	Index	Fat Thick.	Est. Yield Grade	Adj. Feed Conv.	Initial Cond. Score
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)

Owner, address, breed, and sire. (Inserted between sire groups, or in a column at the left.)
Each test group (i.e., breed and age group) should be listed together on the report and averaged. (Age range in each group should not exceed 90 days and breed should be averaged separately within age group.)
Sire group averages are shown for 3 or more progeny of same sire.
If sire groups include calves from different age groups, data may be listed together by sires, but only the average of ratios shown.

(1) Ear tag test number. Tattoo should be recorded elsewhere and may be put on this report if space permits.
(2) Month - day - year of birth. Ex. 2/15/71 for Feb. 15, 1971. If all in the same year, may omit year.
(3) Actual weight used to compute 205 day adj. weight.
(4) Month - day - year when weights were taken to compute 205 day adj. weight.
(5) Weaning weight adjusted to 205 days and for age of dam according to BIF. If creep fed, add C after weight.
(6) Adj. 205 day wt. divided by average of all bull calves in same herd in same weaning season group and same management code. Minimum entrance requirement is optional with test management. The number of calves making the average is listed in parentheses. Ex. 105 (17)
(7) &
(8) Average of at least two full weights taken on different days. May be more than one day apart if desired.
(9) Age at end of test.
(10) Final weight - initial weight ÷ days on test. Minimum length 140 days, no maximum.
(11) Average Daily Gain ÷ test group average of average daily gain. (Breed within age group average.)
(12) $\frac{\text{Final test weight - Actual weaning weight}}{\text{Days between weights}} \times 160 +$ adj. 205 day wt. (adj. for dam's age).
(13) Adj. 365 day wt. ÷ test group average of adj. 365 day weights. (Breed within age group average.)

OPTIONAL
(14) Test wt. ÷ days of age when weighed.
(15) Based on structural soundness and estimated potential for carcass desirability (including carcass weight and cutability).
(16) Indices will vary with individual test objectives. They should all be based on ratios to the group average of a trait multiplied by some percentage figure, thus resulting in values ranging below and above a mean of 100.
(17) Fat thickness may be measured by sonoscope and expressed in hundredths of inches.
(18) Cutability estimates based on sonoscope readings of ribeye area and fat thickness may be classified into the market yield grades of 1, 2, 3, 4, or 5.
(19) Feed conversion of any group fed together in one pen should be expressed as pounds of feed per 100 pounds of gain. The actual amount of feed should be adjusted to a common body weight to eliminate differences in maintenance requirements.
(20) Initial degree of fatness may be visually estimated and scored on a scale of 1 to 5, with 1 being very thin; 5, excessively fat; and 3, average in condition.

BEEF CARCASS EVALUATION

The product, beef, is the end-point of all beef cattle improvement programs and activities. Quality of product and quantity of edible portion are the basic factors of carcass merit. However, the relative value of quality and the relative value of quantity are subject to change as market demands change.

Carcass evaluation is the technique by which the components of quality and the components of quantity are measured. The methods recommended in this publication are those chosen because of their wide use and ease of application. However, a unified approach to beef carcass evaluation dictates that the methods and techniques recommended here be used as a base.

These are guidelines which may be used in any beef carcass contest.

The objectives are:

1. To identify the type of a carcass that is useful to all segments of the industry from the producer to the consumer.

2. To help identify breeding animals which are producing the desirable carcasses.

3. To help individuals relate live animal characteristics to carcass merit.

BASIC FACTORS OF CARCASS MERIT

Quality refers to the overall palatability of the edible portion of the carcass. The USDA Quality Grade (conformation excluded) is recommended as the base for quality evaluation.

The USDA Quality Grades are Prime, Choice, Good, Standard, Commercial, Utility, Cutter, and Canner. The grades are determined by visually evaluating certain carcass characteristics. These characteristics (excluding conformation) are maturity, marbling, texture of lean, color of lean, and firmness of lean. Once determined, the final grade should be reported by one-third of a grade. It is often desirable to independently record the score for one or more of the characteristics which make up the grade.

Many people are particularly interested in the degree of marbling. If so, they should make sure that the marbling score is recorded. In sire evaluation programs, it is recommended that the score for all components of the quality grade be recorded. Low choice quality is recommended as a minimum goal in sire evaluation programs and carcass contests.

Warner-Bratzler shear test and taste panel test have been recommended as methods of measuring tenderness; however, cost may restrict usage.

Quantity is the amount of saleable meat the carcass will yield.

It is recommended that USDA Yield Grade be used as a basis for evaluating carcass quantity.

There are five USDA Yield Grades numbered 1 through 5. Yield Grade 1 carcasses have the highest yields of retail cuts; Yield Grade 5 the lowest. The USDA Yield Grades are based on four factors:

1. Hot carcass weight.
2. Ribeye area at the 12th rib.
3. Fat thickness at the 12th rib.
4. Estimated percent kidney, pelvic, and heart fat.

The Yield Grade can be expressed in whole numbers from 1 to 5 or in tenths of the grade. For example, a carcass will have a Yield Grade 2.0 whether it is 2.0 or 2.9. A 3.9 Yield Grade indicates that a carcass is one-tenth better than a 4.0; however, it is still a Yield Grade 3.0. Yield Grades should be expressed to a tenth of a grade. The Yield Grade can also be expressed as a percentage. This percentage estimates the percent trimmed boneless retail cuts from the round, loin, rib, and chuck.

This percentage figure is commonly referred to as cutability. Various cutability figures correspond to Yield Grades for example:

Yield Grade	Cutability (Percent)
1.0	54.6
1.5	53.5
2.0	52.3
2.5	51.2
3.0	50.0
3.5	48.9
4.0	47.7
4.5	46.6
5.0	45.4
5.5	44.3

The formula for calculating percent cutability is:

Percent cutability = 51.34 - 5.784 (single thickness of fat over longissimus dorsi in inches) - .462 (estimated percent kidney, pelvic and heart fat) + 0.740 (area longissimus dorsi in square inches) - 0.0093 (hot carcass weight in pounds).

Pre-slaughter growth rate is an important part of all performance programs. However, measures of growth rate prior to slaughter do not measure the composition of the gain. In order to measure the composition of the carcass in terms of growth rate, it should be expressed as pounds of trimmed retail cuts (cutability) per day of age. Example: Pounds of trimmed retail cuts per day of age = carcass weight x cutability (in percent) ÷ age in days. For example:

600 pound carcass
52.3 percent cutability (Yield Grade 2)
365 days of age

600 x 52.3 = 314 ÷ 365 = .86 pounds of trimmed retail cuts per day of age.

600 pound carcass
50.0 percent cutability (Yield Grade 3)
365 days of age

600 x 50.0 = 300 ÷ 365 = .82 pounds of trimmed retail cuts per day of age.

USING CARCASS EVALUATION

Not all producers will need complete carcass data. Feeders evaluating their buying and management practices may need only the quality and yield grades. Commercial producers checking their breeding programs may need the quality grade by thirds and the yield grade by tenths. In sire evaluation programs and other more sophisticated programs, the user should consider the recording and use of complete data, i.e., all components of both the quality and yield grade.

OBTAINING CARCASS FVALUATION

Persons desiring carcass data should plan in advance. Identification of the cattle to be slaughtered is a must if individual data are desired. Although many research and Extension personnel are qualified and can collect carcass data, their services are not always available. In most cases, if requested, data can be collected by the USDA Grading Services.

USDA'S CARCASS EVALUATION SERVICE

This service is provided on a fee basis and may be requested from any USDA Meat Grading Office. The fee will vary depending upon the amount of information requested and expenses incurred by the grader, such as travel.

After the carcass is chilled, the grader records the information requested for each animal on a USDA form which is forwarded to the producer or feeder requesting the service. A copy of the form follows.

Note: Persons planning to use this service should contact the grading service well in advance of the time the cattle are to be slaughtered. They should also alert the packer of their intentions to have the cattle evaluated and request his cooperation.

FORM LS-106
(3-1-66)

BEEF CARCASS EVALUATION REPORT

U. S. DEPARTMENT OF AGRICULTURE
CONSUMER AND MARKETING SERVICE
LIVESTOCK DIVISION

USDA NO.	OTHER IDENTIFICATION	BREED *(As supplied by owner)*	MEAT GRADING CERTIFICATE NO.

NAME OF PRODUCER | NAME OF PACKER

1 QUALITY GRADE

BY THIRDS

A. CONFORMATION, MARBLING, AND MATURITY FACTORS

CONFORMATION	DEGREE OF MARBLING	MATURITY (APPROXIMATE AGE SHOWN) *(Circle one)*
		A *(Under 30 mos.)* B *(30 to 48 mos.)* C D E *(Over 48 mos.)*

B. OTHER FACTORS

TEXTURE OF MARBLING *(Check one)*

☐ FINE ☐ MEDIUM ☐ COARSE

COLOR OF LEAN *(Check one)*

☐ VERY LIGHT CHERRY RED ☐ CHERRY RED ☐ SLIGHTLY DARK RED ☐ MODERATELY DARK RED ☐ DARK RED ☐ VERY DARK RED ☐ BLACK

FIRMNESS OF LEAN *(Check one)*

☐ VERY FIRM ☐ FIRM ☐ MODERATELY FIRM ☐ SLIGHTLY SOFT ☐ SOFT ☐ VERY SOFT ☐ EXTREMELY SOFT

TEXTURE OF LEAN *(Check one)*

☐ VERY FINE ☐ FINE ☐ MODERATELY FINE ☐ SLIGHTLY FINE ☐ SLIGHTLY COARSE ☐ COARSE ☐ VERY COARSE

2 YIELD GRADE

BY TENTHS

YIELD FACTORS

CARCASS WEIGHT *(From packer's hot wt. tag)*	FAT THICKNESS *(Inches, nearest 1/10 in.)*		RIB EYE AREA *(From Grid)*	KIDNEY, PELVIC AND HEART FAT *(As percent of carcass weight)*
LB.	IN. ACTUAL	IN. ADJUSTED	SQ. IN. BY TENTHS	PCT. ESTIMATED

(DATE)

(SIGNATURE OF GRADER)

DISTRICT OFFICES
OF THE
USDA MEAT GRADING SERVICE

	Address	Telephone
EASTERN		
Georgia	1718 Peachtree St., NW Room 204 Atlanta, GA 30309	404/526-5159
New Jersey	970 Broad St. Room 901 Newark, NJ 07102	201/645-3951
Ohio	Livestock Exchange Bldg. Room 23 Cleveland, OH 44102	216/631-5535
Pennsylvania	604-C U.S. Customs House Philadelphia, PA 19106	215/597-4535
Tennessee	465 W. Trigg Avenue Memphis, TN 38106	901/948-2815
Virginia	203 N. Governor St. Room 407-C Richmond, VA 23219	703/770-3934
CENTRAL		
Illinois	Room 522 Livestock Exchange Bldg. Chicago, IL 60609	312/923-6520
Illinois	P. O. Box 38 Room 29 Livestock Exchange Bldg. National Stockyards Springfield, IL 62701	618/622-4717
Iowa	225 Livestock Exchange Bldg. Sioux City, IA 51107	712/252-3287

	Address	Telephone
Michigan	6750 Dix Avenue Room 204 Detroit, MI 48209	313/841-2050
Minnesota	Box 27 Post Office Bldg. South St. Paul, MN 55075	612/451-6877
Missouri	760 Livestock Exchange Bldg. Kansas City, MO 64102	816/842-3808
Nebraska	609 Livestock Exchange Bldg. Omaha, NB 68107	402/731-2015
WESTERN		
California	4747 Eastern Avenue Bldg. 7, Section A Los Angeles, CA 90201	213/268-1392
California	630 Sansome St. Room 745 San Francisco, CA 94111	415/556-5816
Colorado	403 Livestock Exchange Bldg. Denver, CO 80216	303/837-4089
Oklahoma	Room 232 Livestock Exchange Bldg. Oklahoma City, OK 73108	405/232-5425
Oregon	217 Livestock Exchange Bldg. N. Portland, OR 97043	503/226-3683
Texas	229 Livestock Exchange Bldg. Ft. Worth, TX 76106	817/624-2714
Utah	200 Livestock Exchange Bldg. Ogden, UT 84402	801/399-6211

CARCASS CONTESTS

Carcass contests are the show window of carcass evaluation. Presently there are many different procedures used. It is recommended that carcass contests be based on specific procedures as recommended by the American Meat Science Association.

Beef Carcass Contest Judging

The following information should be collected for quality beef carcass contests:

1. Age (desirable if can be obtained)
2. Hot carcass weight*
3. USDA quality grade
    a. Conformation
    b. Maturity
    c. Marbling
4. USDA estimated cutability percent
    a. Hot carcass weight
    b. Fat thickness over rib eye
    c. Rib eye area
    d. Estimated percent kidney, pelvic, and heart fat

To aid in placing, each one-third of a grade change in USDA quality grade above low choice may be considered to be comparable to an increase of 0.8 percent in yield of boneless retail cuts. However, the advisability of giving credit for a quality grade above USDA low Prime is questionable. Also, if certain placings are very close and difficult to make with objective measurements, subjective evaluation should be used. Therefore, it is

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* Champion carcasses should weigh within a 550 to 750 pound weight range. It is recommended that all cattle entered in carcass contests be mouthed on foot. Only cattle with all temporary incisors should be allowed in the contest.

imperative that a qualified person or persons be responsible for interpreting the data obtained as well as determining the final ranking of the carcasses in a quality beef contest.

HELPFUL PUBLICATIONS AND MATERIALS

For those interested in beef carcass evaluation, there are other sources of information. Several of these are listed here.

USDA Publications

Beef Carcass Yield Grade Finder

This handy slide rule is useful in determining the yield grade by tenths. On the back is a conversion table showing the percent cutability for each tenth of a yield grade.

Official Standards for Grade of Carcass Beef

This is the official standard by which carcass beef is graded. It covers both the quality and yield grades.

USDA Yield Grades for Beef, Marketing Bulletin No. 45

This bulletin explains in everyday language how the yield grades work and shows some economic differences between yield grades.

The above publications may be obtained by writing to:

United States Department of Agriculture
Agricultural Marketing Service
Livestock Division
Standardization Branch
Washington, DC 20250

American Meat Science Association Publication

Recommended Procedures for Beef Carcass Evaluation and Carcass Contests

This publication has been prepared by the American Meat Science Association in cooperation with the Beef Improvement Federation as a guide to carcass evaluation in beef. The publication goes into considerable detail and should be useful to those interested in beef carcass evaluation.

The above publication may be obtained for a cost of 10¢ by writing to:

American Meat Science Association
36 South Wabash Avenue
Chicago, IL 60603

PERFORMANCE PEDIGREE

A performance pedigree can be a useful tool for the producer in his breeding program. Its usefulness will come into being as a large segment of the industry utilizes performance programs. A major role of progressive recording organizations may be to provide the performance pedigree to seedstock producers.

In the future, the recording organization should combine the genealogy and performance pedigrees. Such a pedigree would contain a complete listing of an animal's performance record and its ancestor's performance and progeny records.

The concise form of such a certificate will make it useful in reporting performance information in sale and promotion efforts. A performance pedigree discourages the use of reporting incomplete or selected performance data.

A performance pedigree should include at least individual performance on the animal, sire and dam, along with progeny information on the sire and dam and could include information through three generations.

The recommendations include a listing of the basic performance information on this pedigree. Additional information may be added to this pedigree as deemed desirable by individual organizations.

No attempt is made to set up any type of format; this will be left to the recording organizations.

Animal's individual record.

205 day adjusted weaning weight
weaning weight ratio
number of contemporaries, weaning
365, 452, or 550 day adjusted yearling weight
yearling weight ratio
number of contemporaries, yearling

Progeny of each individual in pedigree.

Sons - number of calves or yearlings
average - 205 day adjusted weaning weight
average - weaning weight ratio
number of contemporaries, weaning
average - 365, 452, or 550 day adjusted yearling weight
average - yearling weight ratio
number of contemporaries, yearling

Daughters - number of calves or yearlings
average - 205 day adjusted weaning weight
average - weaning weight ratio
number of contemporaries, weaning
average - 365, 452, or 550 day adjusted yearling weight
average - yearling weight ratio
number of contemporaries, yearling

Progeny carcass information.

number of steers, heifers, or bulls
carcass weight
average - USDA quality grade to 1/3
marbling score
percent cutability
fat thickness
loineye area
lbs. of trimmed retail cuts/day of age

Productivity of a sire's daughters.

This information will give a producer an idea of how the daughters of different bulls are producing or milking in his herd.

Average MPPA (Most Probable Producing Ability) for each sire's daughters as compared to her contemporaries or use average weaning weight ratios for this comparison.

Additional consideration.

The inclusion of breeding values for individuals is recommended when techniques and information for specific traits are available.

GENERAL CONSIDERATIONS IN SIRE SELECTION

Sire selection is the key to any breeding program. All sire selection procedures are designed to predict breeding value. Performance of the individual himself, performance of ancestors and collateral relatives, and performance of progeny are all useful tools in sire evaluation. Their relative usefulness varies depending upon whether or not a trait can be measured or estimated in the individual himself, on the heritability of the traits of importance, and on prospective use of the sire or sires selected.

If we set the figure 1.0 to represent complete accuracy in predicting breeding value of a bull, a knowledge of relative accuracies of prediction based on several types of information are of use. For three levels of heritability some key figures are:

1. From individual's own performance only:

Heritability	Accuracy of Breeding Value Prediction
.20	.45
.40	.63
.60	.78

2. From progeny performance only:

Heritability	Accuracy of Breeding Value Prediction			
	10*	20*	40*	80*
.20	.58	.72	.82	.90
.40	.73	.83	.91	.95
.60	.80	.88	.94	.97

* Numbers of Progeny.

3. From combined information on individual's own performance and progeny performance:

Heritability	Accuracy of Breeding Value Prediction			
	10*	20*	40*	80*
.20	.66	.75	.84	.90
.40	.80	.86	.92	.95
.60	.88	.91	.95	.97

* Numbers of progeny.

The accuracy of a breeding value determination applies only to the potential sires evaluated under situations in which they can be validly compared. Comparisons are of increasing value when greater numbers are compared. Within-herd comparisons are subject to less bias due to environmental differences than are between-herd comparisons. The usefulness of all sire evaluation programs is rooted in widespread within-herd testing.

For most growth and conformation characters, heritability is medium to high and the traits can be evaluated in the individual. Whether or not later supplemented by progeny tests, selection on the basis of own performance records supplemented with records of ancestors and collateral relatives should be intense. For most traits, improved accuracy in estimating breeding value from ancestor and collateral relative records is small. An exception to this is weaning weight. Bulls from dams with consistently good records are desired. For this trait a combination of own record and an estimate of "Most Probable Producing Ability" of the dam is recommended.

Lacking knowledge of heritability of between-herd differences, within-herd differences should be the primary criterion for selection on individual performance. Putting bulls in central tests for the post-weaning period to yearling age as a means of minimizing effects of differences in herd environment is desirable. Central testing facilities, preferably provided or sponsored by breed associations, on a scale permitting testing of the top five percent of the bulls would be desirable. The five percent would be selected based on within-herd performance to weaning.

Progeny testing is usually costly and can be justified only for bulls of outstanding merit for traits measurable in the individual

himself. Emphasis in progeny testing should be on traits not measurable in the bulls themselves--carcass traits and maternal ability of offspring.

Generally speaking, the cost of progeny testing can be justified only for selecting bulls to be used extensively in artificial insemination or in very top seedstock herds.

The foregoing relates largely to selection of bulls within herds and points out the difficulties of making objective comparisons of bulls raised in different herds. Generally speaking, the same difficulties are encountered in comparing the progeny of bulls each of which has progeny in only one herd.

A method for systematically producing offspring of some bulls (termed reference sires) in many herds so that their progeny can be directly compared with progeny of test bulls is outlined in the material on a "National Sire Evaluation Program" which follows. This is one method of developing sire comparisons with validity across herds. Some breed associations now have such programs in operation. They offer a means by which any breeder, large or small, can identify germ plasm of potential usefulness in his herd. He can determine how his herd compares with others in the breed through progeny testing one or more sires raised in or being used in his own herd in comparison with reference sires.

NATIONAL SIRE EVALUATION PROGRAM [1]

I. INTRODUCTION

A. Purpose and Scope

The purpose of a National Sire Evaluation Program is to provide breeders with information on "Expected Progeny Differences" between bulls. "Expected Progeny Difference" is the best estimate possible from available data of the difference between the average of a large sample of a bull's progeny from representative cows as compared to progeny of base reference sires when bred to similar cows. The expectation is that information on "Expected Progeny Differences" will aid breeders in making decisions on selection of bulls best suited to accomplishment of specific objectives for the herd. A secondary purpose is to enable breed associations or other sponsoring organizations to measure the direction and magnitude of genetic changes in a breed over time.

Focus of the program should be on measurable characters related to the economic production of quality beef.

A National Sire Evaluation Program for any breed should be planned and conducted by an organization not having direct interests in any specific animal under test. Breed associations may sponsor programs or they may be sponsored by private or public organizations with interests in more than one breed. It is in the interests of all concerned that there not be more than one program per breed. Regardless of whether the sponsoring organization is conducting programs for only one breed or for several, each program should be nationwide with "Expected Progeny Differences" and related information to be on a within-breed basis.

1/ Report of National Sire Evaluation Committee adopted by Beef Improvement Federation, April 1971.

B. Summary of Program

Beef Improvement Federation guidelines for a National Sire Evaluation Program include as a first step the encouragement of herd performance testing as a means of identifying bulls with desired performance characters. Records of individuals ranking high within herds in 205-day weaning weight and 365-day weight will be published for use by other breeders primarily as an aid in making decisions relative to within-herd selections for progeny testing, use in purebred herds or for commercial use. Possibilities for meaningful between-herd comparisons will be very limited in the early stages of a program. Later, as ties are established between herd sires and the reference sires used in progeny testing programs, between-herd comparisons of greater validity will become possible.

Two procedures for progeny testing are outlined. The first is for within herd use. It does not provide for comparisons with sires in other herds. The other involves use of designated reference sires in either single-herd or multiple-herd tests. This procedure permits breed-wide comparisons of bulls under progeny test.

Emphasis in these guidelines is on principles which will permit individual breeds to adapt the program to their specific needs. Traits for which procedures are outlined include 205-day weaning weight, 365-day or 550-day yearling weight, carcass weight per day of age, carcass yield of preferred retail cuts expressed both as a percentage of carcass weight and per day of age, carcass quality grade, cow maternal qualities and progeny testing for deleterious recessive genes. Progeny testing can be sequential with individual breeders and/or sponsoring groups to select the traits to be evaluated in specific programs. Programs need not be limited to traits discussed in these guidelines. The program calls for publication of results and calculation of "Expected Progeny

Differences" for 365-day weight, USDA carcass quality grade and carcass yield of preferred retail cuts per day of age.

II. INDIVIDUAL BULL PERFORMANCE EVALUATION

In a National Sire Evaluation Program widespread programs of within-herd performance testing in the purebred herds of a breed are a prerequisite. These records identify high ranking individuals within herds, i.e. potential candidates for progeny testing or for immediate use in seedstock herds. In addition to individual performance records, all available information on sire, dam, and sibs should be utilized to estimate "Expected Progeny Differences" with maximum accuracy possible from the data. Initially, between-herd comparisons will be of limited value due to lack of knowledge of genetic differences between herds. Also, there will be few direct ties with other herds.

As the program progresses, the progeny test program (involving reference sires) will develop information on genetic differences between herds and will also involve direct and indirect ties with other herds. These things, together with within-herd performance records will increase validity of between-herd comparisons.

Procedures with some background material for evaluating and publishing individual evaluations are:

A. Weaning weight

Weaning weight is included as part of the report on a bull as an aid in evaluation (1) since it is a part of yearling weight, and (2) as an early indication of the possible maternal performance of his daughters. Weaning weight will be evaluated by BIF procedures and expressed as 205-day weight. Emphasis for weaning weight will be on ratio of the individual bull's 205-day weight to the average of his contemporaries in the same herd.

B. Yearling weight and carcass yield

Yearling weight combines in a meaningful way the growth of an animal over at least two distinct

management regimes. It should be evaluated and expressed by BIF procedures as either 365-, 452-, or 550-day weight. Post-weaning tests may be conducted according to BIF procedures either in herd of origin or in a central bull test. Breeders with fewer than 10 contemporary bull calves in their own herds should arrange to test collectively with other breeders in order to participate in a National Sire Evaluation Program.

Methods for estimating carcass yield of live animals are not considered sufficiently accurate nor consistent from location to location to justify their inclusion in individual evaluations at this time. However, when and if technology permits, live animal evaluation of potential carcass yield should be incorporated for each bull at the conclusion of the post-weaning test.

Publication of individual performance records is optional. If the breeder elects to publish, material to be published will include:

1. Identification

   Breeder, owner, sire, dam, birth date, age of dam, State which raised, State in which post-weaning test conducted, and whether post-weaning test was a single-herd or central test.

2. 205-day weight information

   Adjusted 205-day weight.
   Ratio of adjusted 205-day weight to average of contemporaries.
   Number and averages of contemporaries.

3. 365-, 452-, or 550-day weight information

   Ratio of adjusted 365-, 452-, or 550-day weight to averages of contemporaries from same herd. (If post-weaning test in a central test, ratios as above to average of all animals in test.)

Number and average of contemporaries from same herd. (If tested in central test, number and average of all animals in test.)

When programs have advanced to the point that "Expected Progeny Differences" based on progeny are available for sires of performance tested bulls, then "Expected Progeny Differences" shall be calculated for them and presented with prediction errors for 365-day weight, USDA carcass quality grade, and carcass yield of preferred retail cuts per day of age.

III. PROGENY TESTING FOR GROWTH AND CARCASS CHARACTERS

Generally speaking, progeny testing cannot be justified if it is solely for the purpose of choosing among bulls evaluated for growth in the same herd. However, progeny testing is the only accurate means now available for comparing bulls which are not contemporaries. It is the only method for evaluating carcasses.

Progeny tests can be designed to provide any desired level of prediction error (Appendix 1). Numbers of females in test herds are usually a limiting factor. Thus, decisions which will optimize use of test herds must be made between numbers of bulls to be tested and prediction error of individuals tested.

A. General Rules for Progeny Tests

1. All progeny tests shall be planned in advance and plans approved by the sponsoring organization.

2. The sponsoring organization must develop appropriate procedures for determining that cows within group (group defined as cows of a given breed or cross managed as a single herd or unit) are randomly allotted within age to the bulls under test, that cows are bred as planned, that birth dates are promptly and accurately recorded, that progeny are managed either uniformly or in a stratified fashion so

that all sire groups are represented in each management situation or adequate ties provided, and that records are taken as prescribed.

3. Meaningful progeny tests can be conducted only when two or more bulls are tested.

4. Deviations from any of the items listed in 2 (above) are serious and result in biased sire comparisons.

Two types of progeny test are possible, both are useful, and both should be part of a National Sire Evaluation Program. The first is termed a "Breeder Test" in which there are no ties to other herds or groups and progeny comparisons can be made only within the test. The second is termed a "Reference Sire Test" in which ties to other tests make comparisons on a national basis possible.

B. Breeders Tests

Breeders may test as few (two minimum) or as many sires as they wish for the traits they designate. Bulls in this type of test are ranked by contemporary comparison. Bulls with progeny in different tests and with no ties to other tests cannot be compared. Each breeder is allowed to choose the number of progeny from each bull (hence, to determine the prediction error of the comparisons) and may have many progeny from some bulls and few from others.

The sponsoring organization will summarize and analyze results of these tests and return to breeder. Advantages of this test are that it may be entirely by natural service if desired and that if reference sire progeny are not wanted in a herd, none need be produced.

The principle disadvantage of the breeder test is that comparisons can be made only among the bulls tested. No comparisons with bulls in other herds are possible. If the test is conducted in only

one herd (as would usually be the case), the degree to which results apply generally will not be known. Because bulls used in some herds will be of substantially higher merit than bulls used in other herds, the sire values from breeder's tests cannot be used directly to rank bulls from different herds without bias. Direct use of these sire values would favor bulls compared in the same herd with poor bulls and discredit good bulls used in the same herd with other good bulls.

Sires will be evaluated by appropriate least squares procedures.

C. Reference Sire Test

The obvious solution to the principle problem of the "Breeder Test," namely, that comparisons cannot be made between tests, is to include in each breeder's test one or more reference bulls; bulls who are also used in other herds and can link together the various breeders' bulls. The criterion for ranking breeders' bulls is the "Expected Progeny Difference" between breeders' bulls and the base reference sires. This provides an unbiased ranking of breeders' bulls (see Appendix 2). A national ranking requires that all sires be compared directly or indirectly with one or more sires designated by the sponsoring organizations as base reference sires. The criterion for ranking breeders' bulls on a national basis is:

(Breeder's bull - reference sires) + (Reference sires -
(in breeder's herd) all base reference sires used in breeder's herd)
(all other herds)

Prediction error is measured as the square root of the sum of the expected sampling variance of the comparison (see Appendix 1). If the reference sires have many contemporary progeny, this prediction error should not be appreciably more than a breeder test prediction error.

This procedure for a national ranking of progeny tested bulls recognizes that unknown genetic and management differences between herds are large, yet allows unbiased ranking through carefully designed comparisons in either single-herd or multiple-herd tests. In a single-herd test, the disruption of breeder's management program is minimal as he can continue to breed most of his cows naturally if he desires, requiring only that a representative group of cows in each herd be mated artificially to reference sires.

Multiple-herd testing is to be preferred. It requires that bulls under test produce progeny in a number of herds in which reference sires also produce progeny. Multiple herd testing provides information of more general applicability if genetic-environmental interactions should be important. Further, multiple-herd testing reduces chances for biases of a non-random nature to influence results.

Results will be analyzed and summarized by appropriate least square procedures (see Appendix 3).

Prediction errors of "Expected Progeny Differences" will depend upon numbers of progeny per tested sire and numbers from reference sires in the herd(s) when direct comparisons are made.

As more bulls are tested in either a single-herd or multiple-herd test, it is important to increase the number of progeny from reference sires. Tentative numbers to be required are:

No. Breeders' Bulls Being Tested	Required No. of Calves by Reference Sires
1	10
2	15
3	20
4	25
5	30
6	35
7 or more	40

A number of reference sires should be included in each test. Distribution of semen by the sponsoring organization in units of five ampules is suggested.

Minimum number of progeny by each test bull shall not be specified. However, minimums of 10 to 15 are suggested for reasonable prediction error. Progeny records are regressed toward the breed average according to the formula $\frac{n}{n+a}$ where "n" is number of progeny and "a" is σ_e^2 / σ_s^2. This ratio is around 9 for yearling weight as an example. Thus, with small numbers of progeny, "Expected Progeny Differences" will be small with large prediction errors. Larger numbers will reduce prediction errors.

Both steers and heifers may be included in growth and carcass tests of progeny.

Use of central test stations for the post-weaning phases of progeny testing is recommended where possible. This will tend to broaden the basis for comparisons. It will also often simplify operational problems.

Information published for bulls progeny tested for growth and carcass yield in reference-sire tests should include necessary identification including reference to previously published information (if any) on own performance. Age and/or weight for slaughter shall be specified by the sponsoring organization. For progeny, evaluation shall be by BIF procedures and

published information should include: location of herd(s) and feedlot(s) in which raised and fed, season of birth, average 365-day weight, average slaughter age, average slaughter weight, average carcass weight per day of age, average carcass yield of preferred retail cuts on both percentage and weight per day of age basis, average carcass quality grade, and test averages for each of the foregoing. If feedlot and slaughter phases of the progeny test include other progenies of the same breed and cross from herds not included in the progeny test comparison, the averages for these animals may be published as collateral information. "Expected Progeny Differences" should be published for 365-day weight, USDA carcass quality grade, and carcass yield of preferred retail cuts per day of age.

D. Reference Sire Program

For a breed to have a National Sire Evaluation Program requires cooperative effort on the part of individual breeders and the sponsoring organization to develop and conduct a sound reference sire system. The criteria for a reference bull is that he have a large number of progeny evaluated in a large number of herds such that a comparison made through this bull has a low prediction error. The necessity to cooperate with a bull stud in the collection, storage, and distribution of reference sire semen is obvious. The sponsoring organization must designate sires to be reference bulls at the outset and develop criteria for new reference sires. This program offers a unique opportunity to actually measure genetic change in the breed over time by comparing back to the initial reference sires.

The first set of reference sires and their successors shall be chosen by the sponsoring organization as representatives of bulls thought to be the best of the breed. Bulls

designated as reference sires can be used immediately for this purpose through use extensive enough to provide at least 100 progeny by the end of the first breeding season. These 100 progeny must include comparisons with at least 5 progeny by each other reference sire or by a minimum of 10 reference sires whichever is lower.

When semen production permits, each reference sire should be used at least two years. This will permit calculating "Expected Progeny Differences" in progeny tested bulls relative to both the original or base reference sires and to current reference sires.

With small numbers of reference sires, adequate supplies of semen should be placed in storage to provide links to the original base reference sires in case of death or infertility.

IV. PROGENY TESTING FOR MATERNAL TRAITS

Daughters of bulls progeny tested for growth and carcass characters may be retained and evaluated for maternal traits either by breeding all to a single bull or by distributing at random to a number of sires. In a herd being used continually for progeny testing, these would be the bulls under test in subsequent years.

Primary evaluation would be on 205-day adjusted weight of progeny. Since heritability of maternal ability is lower (probably about .30) than for most growth and carcass traits, larger numbers will be required for comparable prediction errors.

V. PROGENY TESTING TO DETECT UNDESIRABLE RECESSIVE GENES

Bulls may be progeny tested for undesirable recessive genes by two methods. Both test simultaneously for all recessives. The first of these is breeding by artificial insemination to a large cross section of the female population of the breed. The probability of detection of an undesirable recessive is related to the frequency of the gene in the population. Probability of detection equals $1 - (1 - 1/2\ q)^n$ where "q" is the gene frequency in

the female population and "n" is the number of progeny. If a problem is detected by this procedure and if the germ plasm is otherwise valuable, more intensive means of progeny testing sons of the carrier bull should be used. This approach allows a relatively short generation interval in bulls used in artificial insemination and will be effective in keeping undesirable genes at a low frequency.

The second method of evaluation involves breeding a sire to a group of his own daughters. The number of such matings determines the precision of the test. If a bull is a carrier, "q" will equal .25 in the formula given earlier and this formula will apply. The production of only normal offspring from 22 daughters gives a probability of 19 in 20 ($p<.05$) that the sire does not carry a specific recessive gene. From 35 daughters, the probability is 99 in 100 ($p<.01$).

An organization sponsoring a sire-daughter test for the detection of undesirable recessive genes must adhere strictly to specific rules. These include individual identification of the daughters, pregnancy determination and reports to sponsoring organization of pregnancy status at least 140 days prior to expected parturition, observation of living calves by a disinterested party, and examination of late abortions and dead calves by competent veterinary or animal science personnel. The latter of necessity must involve preservation and transportation of dead calves.

Information to be published on this test should include identification and reference to previously published individual and progeny performance records. Items specifically related to this test should include number of daughters bred, number of normal calves produced and specific identification and description of abnormal calves. For sires producing only normal calves, the probability of freedom from undesirable recessive genes should be given.

It is suggested that an initial report be made when 10 normal calves ($p<.25$) have been born or when any abnormal calf has been produced.

COMPUTER RECORDS STANDARDIZATION [1]

The development of uniform reporting of basic information is considered an important objective by the Beef Improvement Federation. Toward this end, a standard set of input forms for weaning and yearling information has been designed and is in print. Five State Beef Cattle Improvement Associations in the Southeastern area are currently using these forms, and they are available to other organizations.

Beef Improvement Federation further recommends that consideration be given to providing for the recording of cow weight and condition and of calving difficulty. While no specific recommendations for the utilization of such data are made, it is felt that future interest in both areas is probable.

It is recommended that the descriptive aspect of performance records be emphasized rather than the competitive one. A complete picture of all phases of an animal's development seems more consistent with evaluation of breeding value than emphasis on only those traits in which the individual excells.

The following uniform codes for data reporting are recommended:

I. BREED:

A. System - Suggest the same system as is currently being used by PRI which involves the use of 4 numerals or letters or combinations that will explain 1/2 to 15/16 blood animals and straightbreds. The first numeral or letter is that of the sire, the second is that of the sire of the dam, the third is the sire of the granddam and the fourth is the sire of the great granddam. This system assumes purebred sires.

B. Breeds Included and Coding Recommended:

1. Angus	6. Santa Gertrudis
2. Hereford	7. Charolais
3. Shorthorn	8. Brangus
4. Red Angus	9. Polled Hereford
5. Brahman	10. Devon

1/ Report of Computer Systems and Requirements Committee adopted by Beef Improvement Federation, April 1971.

A.	Simmental	N.	Charbray
B.	Beef Master	O.	(not to be used)
C.	Highlander	P.	(open)
D.	South Devon	Q.	(last to be used)
E.	Red Brangus	R.	Red Polled
F.	Milking Shorthorn	S.	Brown Swiss
G.	Galloway	T.	Texas Long Horn
H.	Holstein	U.	Guernsey
I.	(open)	V.	(open)
J.	Jersey	W.	(open)
K.	Murray Grey	X.	Unknown
L.	Limousin	Y.	(open)
M.	Maine Anjou	Z.	Chianina

C. Example of use:

1222 = 1/2 Angus, 1/2 Hereford
1122 = 3/4 Angus, 1/4 Hereford
1112 = 7/8 Angus, 1/8 Hereford
1111 = 15/16 Angus or Straightbred (Purebred)

II. SEX:

A. Single birth (or twins where only 1 is raised on dam)

1. Bull
2. Heifer
3. Steer
4. Heifer born twin to bull

III. CONFORMATION SCORE:

17 +	14 +	11 +	8 +	5 Common
16 Fancy	13 Choice	10 Good	7 Medium	4 Double Muscle
15 -	12 -	9 -	6 -	3 Dwarf

IV. MANAGEMENT CODE:

A. Weaning

1. Dam only

2. Dam and creep feed (6 weeks or longer)

3. Irregulars - For all records not desired in averages. Calves raised under abnormal management such as twin calf raised as twin, nurse cow, foster mother, sick, injured, or deformed calf.

For other contemporary groups involving separate units on different pastures or managements within the same herd, additional codes may be used as follows:

4. Same as 2 (Dam and creep feed)

5. Same as 1 (Dam only)

6. Same as 2 (Dam and creep feed)

7. Same as 1 (Dam only)

8. Same as 2 (Dam and creep feed)

9. Same as 1 (Dam only)

B. Post-Weaning (use as 2 digit combinations)

(1) Age at end of test (1st digit)

1. 12 months (365-day weight)
2. 15 months (452-day weight)
3. 18 months (550-day weight)

(2) Feed Levels (2nd digit)

4. Fitted
5. Full Fed
6. Intermediate Feeding
7. Roughage and/or Pasture

Example of use

14 = Fitted 12 months animal (365-day weight)
25 = Full Fed 15 months animal (452-day weight)
37 = Pasture Fed 18 months animal (550-day weight)

V. CONDITION SCORE:

17 Extremely	14	11	8	5
16 Fat	13 Fat	10 Average	7 Below Average	4 Thin
15	12	9	6	3

Ultrasonic fat thickness may be used in lieu of condition score - record in millimeters.

VI. PROPOSED STATE CODE NUMBERS FOR BEEF PERFORMANCE TESTING PROGRAMS: (same as DHIA uses)

STATE CODE NUMBERS (USDA - DHIA)

11 Maine	34 Michigan
12 New Hampshire	35 Wisconsin
13 Vermont	41 Minnesota
14 Massachusetts	42 Iowa
15 Rhode Island	43 Missouri
16 Connecticut	45 North Dakota
21 New York	46 South Dakota
22 New Jersey	47 Nebraska
23 Pennsylvania	48 Kansas
31 Ohio	50 Delaware
32 Indiana	51 Maryland
33 Illinois	52 Virginia
55 North Carolina	54 West Virginia
56 South Carolina	82 Idaho
57 Georgia	83 Wyoming
58 Florida	84 Colorado
61 Kentucky	85 New Mexico
63 Tennessee	86 Arizona
64 Alabama	87 Utah
65 Mississippi	88 Nevada
71 Arkansas	91 Washington
72 Louisiana	92 Oregon
73 Oklahoma	93 California
74 Texas	94 Puerto Rico
81 Montana	95 Hawaii

VII. COUNTY CODES:

Each State designate - Recommend use of USDA - DHIA codes already set up.

VIII. HERD CODES:

Each State designate.

COMMENTS CODES

CALF CODES

C0 Twin calf - raised on foster dam
C1 Twin calf - raised on own dam as a twin
C2 Calf sick
C3 Calf sold prior to weaning
C4 Not weighed
C5 Calf weighed under 160 days of age
C6 Calf weighed over 250 days of age
C7 Calf died at calving
C8 Calf died due to disease
C9 Calf died for other reason

DAM CODES

D0 Cow died - at calving
D1 Cow died - Disease
D2 Cow died - other reason
D3 Cow failed to calve
D4 Cow aborted
D5 Cow sold - for breeding use
D6 Cow sold - because of age
D7 Cow sold - physical defect
D8 Cow sold - poor fertility
D9 Cow sold - inferior calves

SIRE CODES

S1 Sire owned by another breeder
S2 Sire unknown
S3 Unfertile bull

TEMPERAMENT CODES

T1 Satisfactory temperament
T2 Fair temperament
T3 Poor temperament

GRADER

G1 Official BCIA Grader
G2 Extension Specialist
G3 Extension Agent, Ag. Inst., other Prof. worker
G4 Another breeder
G5 Breeder himself

RECORD UTILIZATION [1]

Records are of no value unless they are used to advantage. There are at least four steps that will be taken by BIF and its member organizations to increase and improve utilization of records.

1. Develop a set of guidelines for performance programs offered to the beef industry by BIF member organizations so that the programs offer records that can be best utilized by the participants.

2. Develop means to promote the enrollment and continued participation of cattlemen in performance programs.

3. Develop pamphlets and brochures on performance record use for all segments of the beef industry including allied industry.

4. Promote record utilization throughout the beef industry using the educational pamphlets and brochures as well as through the many forms of the news media.

Performance programs are primarily geared to the needs of breeding stock producers. Theoretically, if they participated thoroughly and made desired genetic change by using the performance records in selection, the beef industry would prosper and improve. But actually participation and use of records for selection has been minimal because idealism and the purse have not been closely attached. If performance records are useful, they must reflect this in the bank. Performance records are an economic asset throughout the entire beef industry. Today such records do not exist in a volume necessary, are not utilized effectively by most of those who have them, and are not understood by the industry participants for their economic advantage.

Organizations within BIF need to consider designing specific programs developed to generate profitable record systems for other segments of the beef industry other than traditional breeding stock herds. Attempts have been made in this area such

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1/ Report of Record Utilization Committee adopted by Beef Improvement Federation, April 1971.

as feeder calf programs in which a sample of the product offered for sale is tested and in feedlot business analyses in which the value of genetic potential for gain can be dramatically demonstrated. In these areas lie the opportunity to utilize economic records.

The essence of record use is "SELECTION" in the broad sense. That is, records must be used in decisionmaking of the enterprise or they are simply an expense. In breeding stock programs, records must be used in selecting parents to make genetic change. In commercial breeding programs, records must be used in selection of parent stock both within the program and in evaluation of breeding herd programs from which to obtain breeding stock. Also in both programs these records, properly evaluated, can be aids in many management decisions. This is not genetic selection, but selection among alternatives just the same. In commercial feeding enterprises, records are necessary in evaluating sources of stock and determining optimum management. Specification in terms of economically important records not just groundless advertisement is becoming the rule in all segments of the beef industry. The development of a PERFORMANCE REPUTATION is the key to tomorrow's success.

GUIDELINES FOR PERFORMANCE PROGRAMS

What follows is a list of simple guidelines for a complete breeding stock program adopted by BIF in 1971.

1. Each calf crop starts with the mating decisions a year prior to the birth of the calf crop. A complete breeding stock program should have convenient forms to record matings planned and matings made as well as date of breeding if these are known. At the conclusion of a pregnancy exam or after breeding, these breeding records can be sent to the organization office where these records could constitute the prelist for birth and weaning data the following year. Such a system would provide an easy way to keep up with the reproductive performance of the cow herd. Further they would provide information for a breed association in registration and thus eliminate the need for the breeder to fill out separate forms. This would tie performance to registration procedure in a useful way.

2. Each performance program should be designed to be simple for the participant, breeder, or better yet the customer. To be simple requires that worksheets be prelisted in some useful sequence, that previous weights be given if applicable, that the sheets be of a convenient size for easy writing, that the paper be of high enough quality to withstand a reasonable amount of moisture, that the space for recording the weight or measure be large enough for cold fingers, and that turning pages to find particular animals be facilitated. The prelisting will save customer effort and assure an accounting of the animals being tested. Much of the time performance programs have been developed with the data flow being the primary consideration. The breeder, not the program system, is the customer. Using carbons on the farm needs to be avoided whenever possible. With the advent of copy machines, hand copying of records by the breeder is obsolete and besides errors are generated. Records can be sent in, copied, and sent back in a relatively short period of time. The less desk work required of the customer, the greater will be the participation. If the cowman liked desk work, instead of livestock and the outdoors, he would have a desk job!

3. Each performance program needs to be designed such that the adjusted and analyzed records are available to the breeder at the time they can be used in selection and in other decisionmaking. Adjusted weaning weights are of little value after the replacements have been selected and the culls disposed of. Dam summaries are nice to have after the pregnancy exam and culling prior to the dry period, but are of so much more value if they are available when the selections are made. The general rule for record processing is "raw data in processed data out as soon as physically possible." Often less than a complete calf crop is sent for processing. These contemporary groups should be processed immediately rather than when all the calf crop is completed. Such procedure should encourage the customer to bunch his calf crop as much as

possible in order to compare more individuals accurately within contemporary groups. Record summaries need to be sent to the customer when they can be used. Dam summaries need to be available when cows are culled and this may need to be on breeder request. Sire summaries should be available especially for yearling and carcass data before sires are selected to go into the breeding season. To miss carcass data, due to lag time, on a group of sires means another year added to the already long generation interval.

4. Each performance program needs to be designed so that all the available information on a trait, for a particular set of individuals to be compared, is utilized. The records on close relatives exist in the data sets for herds and can easily be used to provide the customer with all the information available from the performance organization. Provided the data sets are properly stored, the average performance of paternal and maternal half sibs can be combined with the individual's own record of performance to better rank the contemporary individuals based on their estimated breeding value. When progeny are available, this average can be used also. Obviously, this takes programming skill to sort through the data finding the relevant records and to compute breeding values using multiple regression techniques. But with today's computers such a task is very quick. For the breeder to do this is a physical impossibility. Thus, the performance organization can provide a service that is impossible for the breeder to do. Ranking of individuals on their estimated breeding value using all available information for a trait will increase the accuracy of selection.

   As an example, at weaning the bull and heifer calves could be ranked separately based on their weight and the average weight of their paternal and maternal half sibs. From this selection worksheet (a current ranking to be used), a breeder could make his tentative heifer selections and decisions on what bull calves to feed. Along

with this ranking, the cows just weaned could be ranked on their record, the average record of their paternal and maternal sibs, and the average record of their progeny. The MPPA uses only progeny information. Then the selection worksheet could be used as an aid in culling the cow herd. After the yearling test, the procedure could be repeated using all available information for yearling weight. This selection worksheet would be useful in selecting young bulls and, if one were made on all sires, in comparing the young bulls with current herd sires. Such a selection worksheet available before breeding would materially aid in selection accuracy of the bulls.

The use of this procedure is dependent on having the majority of each calf crop contemporary since to account for environmental differences the deviations or ratio deviations must be used in the estimation procedure. Also, to assure that records from several years can be combined into meaningful estimates, the management and program in the herd must be as consistent as possible over years.

5. The honesty and accuracy of the cowman in keeping records is the very backbone of the system. Our beef industry is built on this. Although certification of weights by a disinterested party helps verify the program, it is not essential. The breeding stock breeder sells breeding values and that's how the calves of his stock performs for the buyer. When his stock don't perform for others, free enterprise solves the problem. Probably we should encourage seedstock breeders getting disinterested parties to help them.

6. More abbreviated performance programs need to be developed for the large commercial producer. This will involve a sampling procedure (quality control) in which a sample of calves, or the product he offers for sale, are fed out and the gain and carcass information obtained. This allows the commercial producer to assess what breeding stock he needs and to compare between

sources, if possible, as well as develop a sound performance reputation. The small commercial producer can best compete by keeping more detailed records with cow identification.

7. Sound feedlot record programs need development so that genetic groups, sources of cattle and programs of feeding can be compared. These programs need not be elaborate, but should include a sample of animals evaluated on the rail. In this way, the feedlot operator generates his performance reputation.

8. Performance programs need to adapt quickly to a unified sire evaluation program when such develops. Since sire selection is the key to genetic change in the beef industry, this is imperative. Adoption of uniform testing programs for performance of individual bulls and for uniform progeny evaluation will be necessary.

9. All cattle in herds should be involved in the programs.

PERFORMANCE PROGRAM PARTICIPATION

Record utilization at present suffers because not enough herds are participating or are continuing to participate. Several guidelines were developed as follows to encourage participation.

1. Development by each performance organization of a clear concise write up of procedures to follow in enrolling and continuing to participate is essential. A simple review with the new breeder in mind, not the data flow, can help a lot. The organization should develop a calendar of record keeping to help the breeder plan his program. The order involves calving, yearling, breeding, weaning, etc. Note that three calf crops are involved in any one calendar year. First, last year's crop must be evaluated as yearlings; second, this year's crop must be born and weaned; and third, next year's crop must be bred for. This is the form of the breeding program. Calving twice a year compounds the problem and calving the year around presents near

insurmountable problems unless the management is artificial to assure some uniformity. Real effort needs to be expended in this area to develop a simple procedure that gets the message across and does not scare breeders off. Uncluttered forms will help and fairly uniform, over organizations, input and output forms would aid in explanation.

2. To become acquainted with a set of records and what they can be used for, would be a significant aid in interesting new participants in a performance program. While obtaining enough backlog of records to be useful, is the time a lot of breeders quit. If they could practice on a dummy set of records already computed for them, they could see selection operate (learn genetic principles) as well as become better acquainted with the forms and procedures. Such a tool is available in the computer cow game. It could be played in groups of say 50 new breeders just enrolling in a program. They could be asked to participate in the game over say 5 calf crops to see just how a performance program can be made to work for them. Also, breeders already keeping records might want to try out several selection schemes to find out which might be the more successful before they launched their new life-time program. This could be done by having three or four simulation herds at once. The opportunities to educate customers using the computer cow game are limitless.

3. Educational material in depth will be developed by BIF and specifically by the member organizations on just how to use records in selection and in the entire process of beef production. The sights for such material needs to be both for the experienced record cowman and for the novice. They will not be of the same content. For an organization to serve its customers, requires it to challenge all. No breeder today is utilizing his records for selection at near maximum potential.

4. There should be cooperation between all performance programs operating in a State.

5. The beef industry needs a book on beef breeding principles.

EDUCATIONAL MATERIAL DEVELOPMENT

The entire beef industry has need for knowledge concerning the use that can be made of records in the development of a specification product by the industry. This committee along with the ones involved in education need to write pamphlets and brochures on record use for the entire beef industry. To some segments such a writing will need to explain the system of performance records and what can be learned about the participants and their cattle from examination of their breeding programs. For other segments, such a writing must involve suggestions for their participation in performance record systems. What follows is a list of particular segments that might utilize such written information.

1. To cattle feeders both corporates and individuals. Questions such as how to buy on performance records, what to expect from extra gaining ability, etc., could be answered. This segment is most important because of the reflection back to the cow-calf man and then to the breeding stock supplier.

2. To feed companies for incorporation into their cattle feeding programs using their feed. This is a real source of distribution.

3. To livestock bank loan officers. A well done brochure on the dollars and cents of performance records in cattle herds would be received with great interest in banking organizations. And we need the capital.

4. To breeding stock herds especially through their various breed associations. Such writing could include an evaluation of breed needs in a crossbred commercial industry and such topics.

5. To commercial cow-calf operators through the State and national cattlemen's organizations.

Sire selection for commercial production would be the item to stress or utilizing crossbred vigor in a designed program would be of value.

6. The publishing houses especially the breed organs desperately need some guidelines on what constitutes proper advertisement of records and what does not.

7. The business world as a source of volume capital needs an introduction to performance records and their use in evaluating a proposed deal.

8. To the packing, processing, and retail industries. Such a pamphlet could reflect the use of records in developing for their industries a specification product.

9. To the livestock Extension activities. This could include 4-H and FFA. A concise statement about performance records and their use in the entire beef industry would be beneficial.

10. To livestock marketing agencies. Such writing could consider economic aspects of buying and selling based on performance records as the start for performance reputations.

Actually the first objective of such material development would be to simply take a long hard look at the potential for the use of performance records in all segments of the giant beef industry. They are many. The second objective is to get the developed material read and acted upon by leaders of the beef industry. Either one or both of the objectives will be difficult but should be worth the effort.

The need exists to help organize merchandising mechanisms between cow-calf men and feeders.

PROMOTION OF RECORD UTILIZATION

Once several brochures have been developed, these need to be circulated through a concentrated promotion program. Such a program needs to be organized and must utilize every means possible to get the information into the hands of the men of leadership in the various segments of the beef industry.

To utilize their own groups or organizations to get the information out would be profitable. These publications must be simple, well illustrated, and yet get the basic information to the reader.

The news media and farm press is another avenue available for an organized promotion effort. They have more than supported us in the past in the performance movement. To promote through the news media requires that the information be "news" and that is not easy. There are many human interest stories waiting for the writing. Such stories involve the particular development by a breeder of a performance reputation worthy of note. These "how it came about" stories are the keys to interesting other breeders in becoming involved in performance. They are better promoters than any "how to do it - step-by-step" brochure!

ADVERTISING[1]

Advertising is a means of representing or selling a product to a potential user or buyer. It represents an operating expense to the beef cattle breeder for which he expects a substantial return. Within a democratic society, the breeder has the right to use his own system of merchandising his product.

In general, advertising presentations and formats are and have been well done in relation to the purpose for which they have been intended.

When performance data are used in advertising, they should be accurately and concisely presented. This is the purpose for developing guidelines for using performance data in advertising beef cattle.

Beef Improvement Federation recommends use of standardized records such as 205-day and 365-day adjusted weights, cutability data, weight ratios and number of contemporaries. Mature weights, if used, should not be substituted for standard BIF records. If such weights are presented, the age of the animal should be stated.

Certain data uses, phrases, etc., are considered misleading or superfluous and their use in advertising should be discouraged. Examples are:

1. "During a 60-day test this bull gained 5#/day."
2. "Sonoray rib eye at 2165 lbs. was _____."
3. "Weight of this bull at 23 months and 5 days was _____."
4. "Calf weighed 363 lbs. at 4 months and 19 days."
5. "The last 3 calves by this sire weighed 628 lbs."
6. "This bull weighed 1,300 lbs. at 14 months."
7. "One calf sired by this bull weighed 1220 at 14 months."

MAGAZINE AND CATALOG ADVERTISING

The following are possible layouts for incorporating performance records with pedigree, footnotes, etc., into advertising in trade journals or sale catalogs.

1/ Advertising Committee Report adopted by Beef Improvement Federation, April 1971.

ANIMAL BEING ADVERTISED:

Format 1: Example of Data Presentation in Advertising Young Breed Animals.

	205 Day Adj. Data			Weight Per Day of Age or 365 Day Adj. Data on Bull Progeny		
	No.*	Weight	Ratio	Grade	No.*	Weight	Ratio
INDIVIDUAL'S RECORD (CREEP: yes or no)							
SIRE'S PROGENY RECORD							
DAM'S PRODUCE RECORD							

*No. of contemporary test mates on individual records and total number tested in progeny records.

Format 2: Example of Data Presentation in Advertising Sires for Sale or Reference.

	205 Day Adj. Data			Weight Per Day of Age or 365 Day Adj. Data on Bull Progeny		
	No.*	Weight	Ratio	Grade	No.*	Weight	Ratio
INDIVIDUAL'S RECORD (CREEP: yes or no)							
PROGENY RECORD							

PROGENY CARCASS DATA	No.*	Ribeye Adj.**	Carcass W/DA	Fat Thick-ness	Cut-ability	% Choice or Higher	Carcass Weight

* No. of contemporary test mates on individual records and total number tested in progeny records.
**Adj. by regression: RA = REA - (WT - 600) x .001.

Format 3: Example of Data Presentation in Advertising Individual Dams.

	205 Day Adj. Data				Weight Per Day of Age or 365 Day Adj. Data on Bull Progeny		
	No. Calves	Weight	Ratio	Grade	No.	Weight	Ratio
PRODUCE RECORD							

INFORMATION ON CALVES CONSIGNED

	Name of Bull Calf	Reg.	Birth Date Mo. Da. Yr.		Tattoo

BREED | CONSIGNOR NAME AND ADDRESS | LOT

Sex	Check If Purebred	Percent If Not Purebred	Check If Polled	205 Day Wt.	205 Day Wt. Ratio	Weaning Grade	365 Day Wt.	Yearling Wt. Ratio

PEDIGREE

Sire Name

SIRE

REC.

PROGENY RECORD

NO. CALVES ____ AVE 205 WT ____ 205 WT RATIO ____ AVE GRADE ____

NO. BULLS ____ AVE 365 WT ____ AVE 365 RATIO ____

PROGENY CARCASS DATA	No.	Ribeye Adj.	Carcass W/DA	Fat Thickness	Cutability	% Choice or Higher	Carcass Weight

GRAND SIRE REG. ____

GRAND DAM REG. ____

DAM

REG. ____

PROGENY RECORD

NO. CALVES ____ AVE 205 WT ____ 205 WT RATIO ____ AVE GRADE ____

NO. BULLS ____ AVE 365 WT ____ AVE 365 RATIO ____

GRAND SIRE REG. ____

GRAND DAM REG. ____

Do not write in this space (1-3) (4-5) (6-8) (9) (10-11)	Name of Bull Calf (13-42)	Reg. (43-52)	Birth Date (53-58) Mo. Da. Yr.	205 wt. (59-62)	Tattoo (63-67)

BREED | CONSIGNOR NAME AND ADDRESS | LOT

Sex	Check If Purebred	Percent If Not Purebred	Check If Polled	205 Day Wt.	205 Day Wt. Ratio	Weaning Grade	365 Day Wt.	Yearling Wt. Ratio

Do not write in this space

PEDIGREE

Sire Name (13-42)

SIRE

REC. (43-52) ____

PROGENY RECORD

NO. CALVES ____ AVE 205 WT ____ 205 WT RATIO ____ AVE GRADE ____

NO. BULLS ____ AVE 365 WT ____ AVE 365 RATIO ____

PROGENY CARCASS DATA	No.	Ribeye Adj.	Carcass W/DA	Fat Thickness	Cutability	% Choice or Higher	Carcass Weight

GRAND SIRE REG. ____

GRAND DAM REG. ____

DAM

REG. ____

PROGENY RECORD

NO. CALVES ____ AVE 205 WT ____ 205 WT RATIO ____ AVE GRADE ____

NO. BULLS ____ AVE 365 WT ____ AVE 365 RATIO ____

GRAND SIRE REG. ____

GRAND DAM REG. ____

APPENDIX 1. BIF SIRE EVALUATION REPORT

Prediction Error of Own Performance (n = number in contemporary average)

n	Std. Error
1	109
5	84
10	81
15	80
20	79
25	78
30	78
35	78
40	78
45	78
50	77

σ_E = 77 pounds

$$SE = \sqrt{\sigma_E^2 \left(\frac{n+1}{n}\right)}$$

Prediction Error of Expected Progeny Difference

N_B	N_R 10	20	30	40	100
1	37	35	34	33	31
5	33	31	30	29	27
10	31	28	27	26	24
15	29	26	25	24	22
20	28	25	23	22	20
25	27	24	22	21	19
30	27	23	21	20	18
35	26	23	21	20	17
40	26	22	20	19	16
100	24	20	18	16	13

σ_e = 95 pounds $\alpha = \sigma_e^2 / \sigma_s^2$

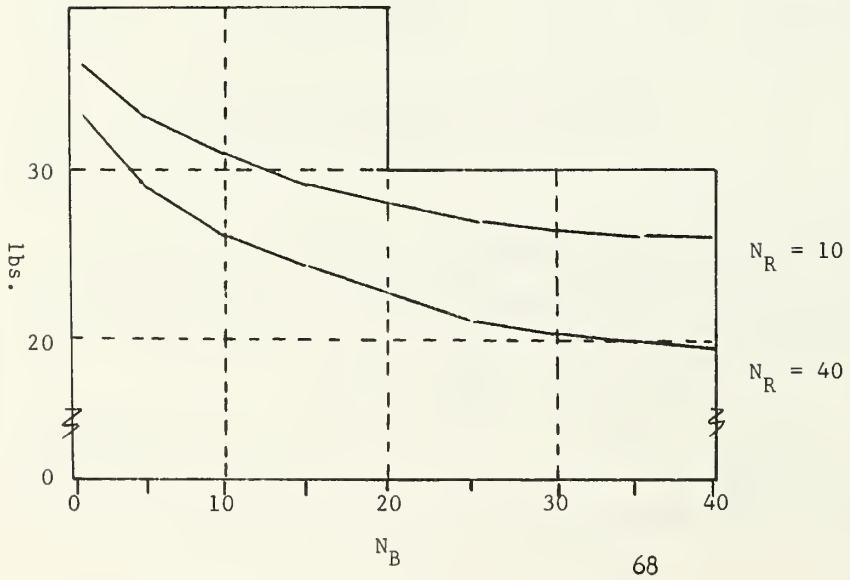
$$SE = \sigma_e \left[\frac{1}{n_B + \alpha} + \frac{1}{n_R + \alpha}\right]$$

$\sigma_s^2 = 1/4\ \sigma_A^2$, $\sigma_e^2 = 3/4\ \sigma_A^2 + \sigma_e^2$

N_R = number of progeny by reference sires

N_B = number of progeny by breeders bull

Graph of Prediction Error of EPD



APPENDIX 2. COMPARISON OF DAIRY AND BEEF PROGENY TEST PROCEDURES

Testing by randomization (dairy)

Randomization and experimental control are the techniques which allow unbiased comparisons to be made. Dairy breeders rely heavily on random distribution among herds of progeny of each sire to test their bulls by what they term the herdmate comparison or "predicted difference" system. Such total randomization is not necessary for unbiased ranking of sires and is not compatible with use of sires by natural service.

The theoretical basis of the herdmate comparison procedure assumes that each cow is subject to the same non-genetic influences as her herdmates except for random sampling variation. Hence, the difference in performance between a cow and her herdmates reflects genetic differences and random non-genetic influences.

The average superiority (or inferiority) of a bull's progeny compared with their herdmates is the criterion used for ranking bulls, and provides an unbiased ranking if no bulls are knowingly favored by comparing progeny with unrepresentative herdmates, by being mated to unrepresentative cows to produce progeny for testing, or by selecting which progeny are to be tested.

Representative mates and representative herdmates are most reliably obtained if each bull has only one progeny in each herd, the herds in which a bull has progeny are randomly distributed and matings within herds are chosen randomly. Accuracy is increased by testing more progeny and by distributing progeny among more herds under the direction of disinterested parties.

Designed comparisons are suggested for progeny testing beef sires so that bulls used naturally in a single herd can be accurately ranked. Comparisons of animals raised together are used to remove environmental biases, but reference sires (rather than randomization) are used as the basis for unbiased comparison.

In summary, dairy proofs rely on randomization whereas the proposed beef proof relies on experimental control to provide unbiased ranking of sires.

APPENDIX 3. ANALYSIS PROCEDURE

Ranking of sires will be computed for each herd as soon as possible after the records are received. National ranking of sires should be made two or three times annually, preferably soon after completion of most tests. The same analysis procedure will be used, but the herd test will produce within-herd ranking only whereas the second analysis will provide a national ranking.

Accuracy of ranking will be the theoretical standard deviation of prediction error. Estimated Progeny Differences will be obtained by fitting the model

$$Y_{ijkl} = T_i + G_j + S_{jk} + E_{ijkl}$$

where Y_{ijkl} is the performance record of the l^{th} progeny of the k^{th} sire of group j raised in treatment group i, T_i is the effect of common environment and maternal influence on progeny in treatment group i (treatment groups are pastures or feedlots under the same management but handled separately), G_j is the effect of genetic group j (reference sires often represent a different genetic group than the breeders bulls), and S_{jk} is the genetic influence of sire jk. A solution for the above equation is obtained after adding σ_e^2 / σ_s^2 to the diagonal element of each S_{jk} equation, and setting the reference sire group effect equal to zero.

The above procedure essentially averages within group comparisons among sire progenies and adjusts for the number of progeny of each sire. The primary difference between the within-herd and national rankings is the data put into the program, the national analysis using all performance records and each herd analysis using only data from that herd.

Correlations exist among bulls tested together because they are linked to the national base by the same progeny of reference sires.

$\bar{X}_1$, $\bar{X}_2$, $\bar{X}_R$ are the EPD of two bulls and a reference sire from the same herd.

$$V\ (\bar{X}_1 - \bar{X}_R) = \sigma^2\ \left(\frac{1}{n_1 + \alpha} + \frac{1}{n_R + \alpha}\right)$$

$$V\ (\bar{X}_1 - \bar{X}) = \sigma^2\ \left(\frac{1}{n_2 + \alpha} + \frac{1}{n_R + \alpha}\right)$$

$$COV\ (\bar{X}_1 - \bar{X}_R,\ \bar{X}_2 - \bar{X}_R) = \sigma^2\ \left(\frac{1}{n_R + \alpha}\right)$$

$$\text{Correlation}\ (\bar{X}_1 - \bar{X}_R,\ \bar{X}_2 - \bar{X}_R) = \frac{n + \alpha}{n + n_R + 2\ \alpha}$$

if n = number of progeny of bulls 1, 2

n_R = number of progeny of reference sires

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